

AN INFORMATICS SYSTEM FOR TRAINING, EXAMINATION AND KNOWLEDGE EVALUATION OF THE FHS PERSONNEL

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ABSTRACT

The paper presents the way to implement a Fuel Handling System (FHS) data base in order to carry out an informatic system for training, examination and knowledge evaluation. The sessions, are organized as "ebooks" represent a way of modern learning and thoroughness, examination and assessment of the professional knowledge.

The use of these lessons for personnel training, working in the FHS area, leads both to the increase of the learning quality and reduction of the time for studying activities. The student is getting the advanced professional knowledge regarding the technological equipment operation by graduating the session.

This e-learning system is designed and used to keep and develop, in time, deep in knowledge, about Fuelling Machine Head construction and working, for F/M Test Rig operators and technicians, from INR Pitești. The e-lessons for F/M snout clamp, magazine and separators have been already implemented, the rest of materials in data base is following.

Key words: eLearning , SIPEC, CANDU, fuel handling, knowledge

Introduction

Education using the computers, named *eLearning*, has had an explosive development during the last years, and has become one of the integrated components in the educational strategies in most of companies and universities. The term *eLearning* is associated to all the programs and materials, distributed to beneficiaries in electronically form, that are used in a learning process, instruction or education.

Was initiated and developed an Informatics System for Perfecting and Evaluating the Professional Knowledge - SIPEC Pro (fig. 1), in order to consolidate the professional knowledge of the implied personnel in operation activities and exploitation of the test rig, so they can be able to test the F/M Head (fig. 2) for the CANDU reactor. The SIPEC Pro is currently in the development stage.



Fig.1 *The Informatics System's logo*

The courses in electronic format (*eBook*) that are found in the SIPEC, contain information and knowledge about the construction and function of the Fuel Handling System's equipment, the adjustment, calibration and maintenance operations, all collected in a dedicated data base [1], [2].

Until now the data base was completed with information regarding the F/M Head, its hydraulic driving system, as well as the new and spent fuel transfer equipment. In the future the data base is going to be completed with the information regarding the testing of the F/M Head, and of the spare Rams.

There were implemented electronic courses for the coupling device, the F/M Head storage and separators; in the future it will be realized for the rest of the materials existing in the data base.

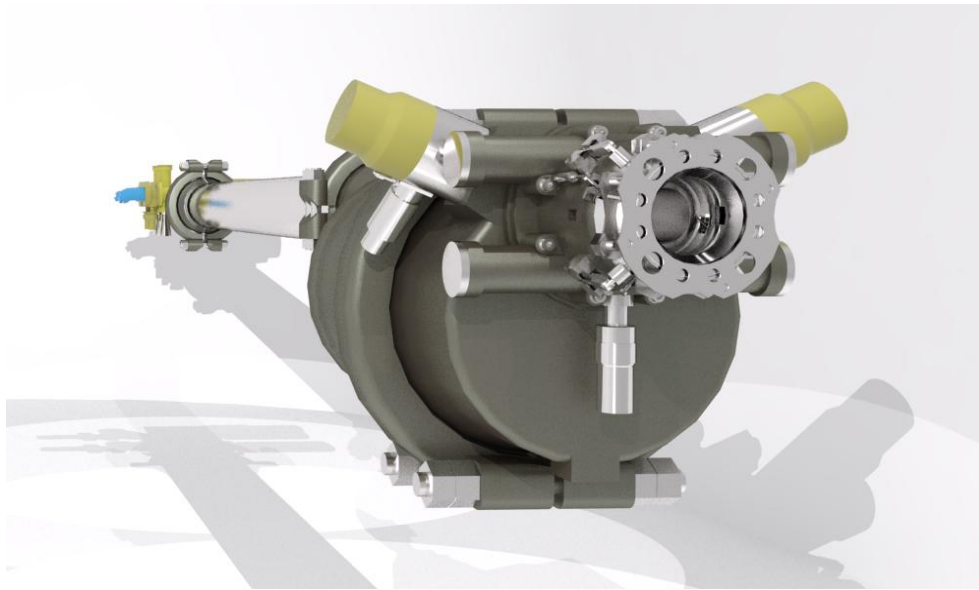


Fig.2 *F/M Head –Virtual assemble image*

The F/M Heads are mechanical robotics, with hydraulic driving, from the Fuel Handling System, which has the following functions in the nuclear plant:

- Takes the nuclear fuel in its own magazine and transports the fuel between the new fuel port and reactor, in order to supply the reactor;
- After positioning in front of the reactor, at the upstream end-fitting of the fuel channel, it checks the correct alignment and the channel sealed coupling;
- Opens the fuel channel, which has a 23 kg/s heavy water flow, a 110 bars pressure and 307°C temperature and transfers the new fuel to the channel;

- Closes the fuel channel and leaves the reactor room towards the maintenance room, where it stays until the next fuel charging operation.

Simultaneous with this operation, at the downstream end-fitting of the same fuel channel, another F/M Head takes over the spent fuel, according to the following operations:

- After positioning and moving in front of the reactor, it checks the correct alignment at the downstream end-fitting of the fuel channel, subject to the charging / discharging operation, and executes the sealed coupling with the fuel channel;
- Opens the fuel channel and takes over the spent fuel inside its own storage;
- Closes the fuel channel and leaves the reactor room towards the spent fuel port where it will transference the whole fuel charging;
- It moves toward the maintenance room, where it stays until the next fuel discharging operation.

Next it will be presented examples of the electronic courses for different F/M Head subassemblies.

DESCRIPTION

F/M Head includes the mechanisms necessary (fig. 3) for fuel bundle manipulation, as it follows:

- The coupling device assembly is a mechanism that blocks the fuel channel terminal fitting and seals at pressure the F/M Head on terminal fitting;
- The F/M Separators assembly realizes the fuel bundle separation from the bundles column, and so facilitates their stocking in the F/M Head storage;
- The F/M Magazine is an assembly that shelters the fuel bundles that are to be inserted in the channel or for the ones removed from the channel, as well as for the protection plugs, channel shutting plugs, bundles guiding sleeve, Ram adaptor and FARE tool;
- Ram pushers, or the telescopic cylinders, is an assembly used to remove or to put in place the plugs, installs or retreats the bundles guiding sleeve and manipulates the fuel bundles.

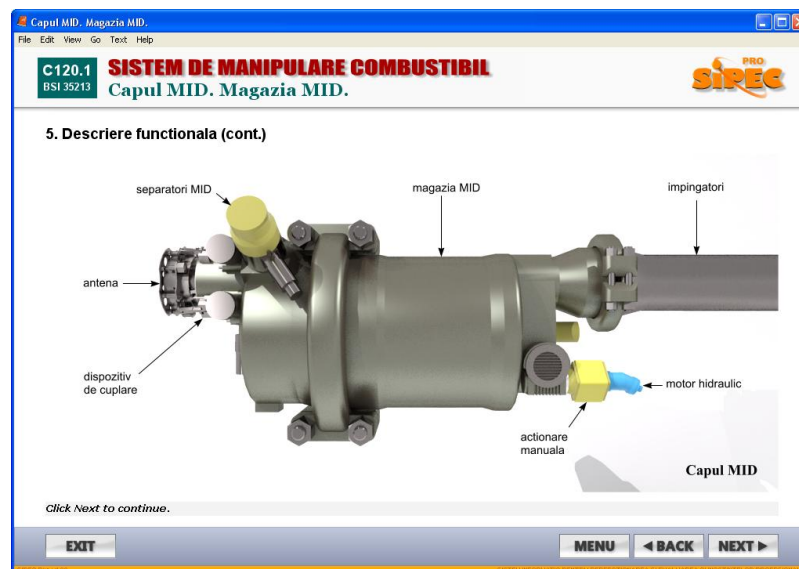


Fig.3 F/M Head subassemblies

The fuel swooping operations must be possible when the CANDU reactor is at nominal power or when is shut down, in any possible temperature or pressure range. The fuel is always charged in the reactor in the coolant flow direction. There is also a possibility that the column bundles can be moved with 2 to 4 cm between the protection plugs and the two heads of the pressure tube, in order to compensate the column thermic dilatation.

During the reactor operation, the bundles are moved from the core of the reactor only by the fluid flow action, under the action of the hydrodynamics forces exerted above it. Because the flow through the fuel channel varies according to its position, for the channels in the peripheral zone on which the flow is reduced, it is necessary using of the FARE device (Flow Assist Ram Extension).

This device isn't necessary for the tubes in the central zone of the reactor core, here being enough the FAF method (Flow Assist Fuelling). The FARE device is charged at the end of the bundle column, after the fresh fuel bundle had been inserted in the upstream machine, and is removed after the bundle column had had reached on position.

F/M Snout Clamp - it is positioned in the front of the F/M Head storage carcass, forming an extension of the pressure zone between the storage carcass and the terminal fitting of the fuel channel, also containing the mechanisms that allows the F/M Head to couple on the terminal fitting, to unlock the channel closure and to assure the air-tight coupling. Its functions are: the aliening of the F/M Head with the terminal fitting and maintaining an air-tight without losses between the machine head and the terminal fitting.



Fig.4 – F/M Head Coupling device

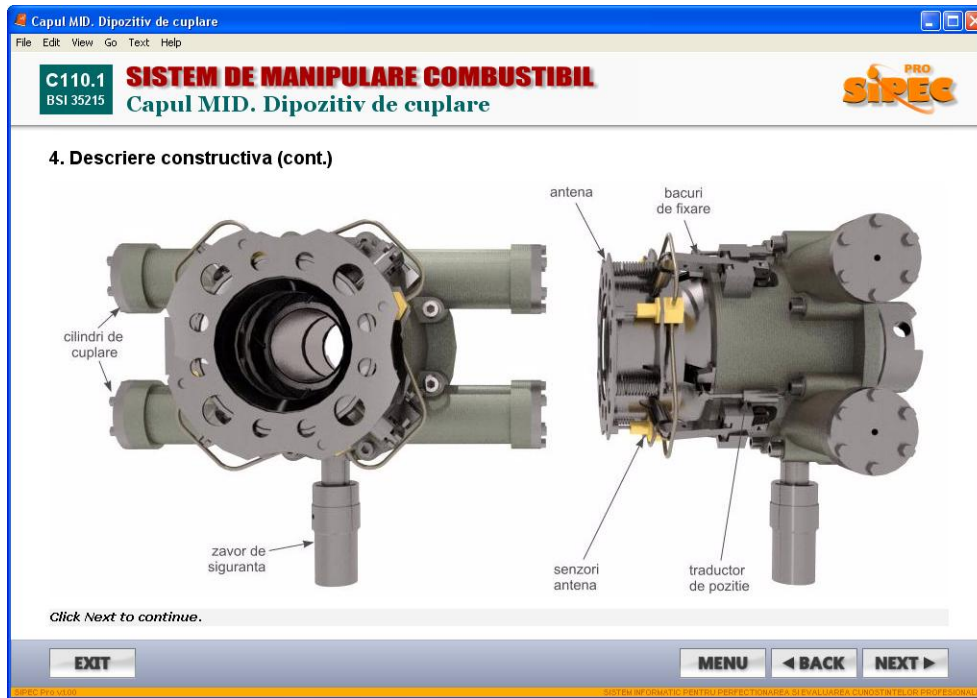


Fig.5 – F/M Head Coupling. Components

F/M Magazine – is an equipment central positioned, between the snout clamp and the pushers, used for new or spent fuel bundle deposition or transportation toward or from the reactor, and the storage of different tools and devices necessary in the fuel changing operations.

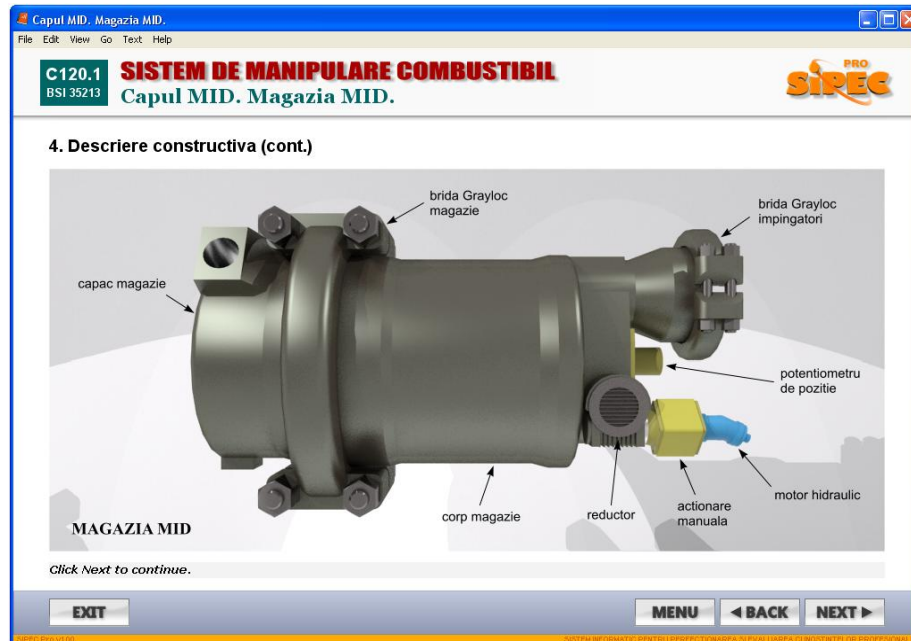


Fig.6 – F/M Head storage

The main magazine subassemblies (fig. 6 & 7) are:

- Rotor assembly, that has 12 tubes with different destinations;

- Action– indexing mechanism, that assures the correct positioning of the tubes;
- Breakdown action mechanism, for manual auctioning of the F/M Head Magazine.

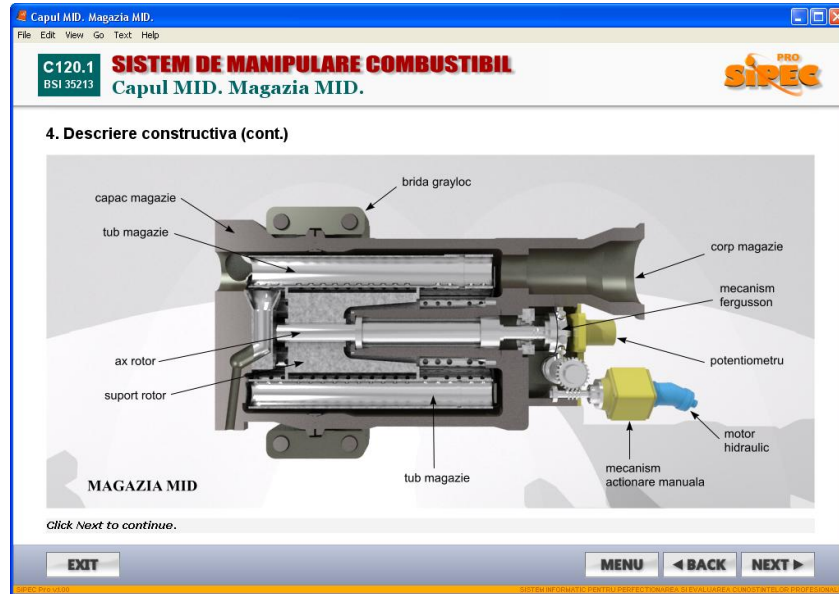


Fig.7 – F/M Head storage. Constructive description

F/M Separators – two assemblies of the F/M Head (fig. 8), mounted behind the coupling device, that:

- Feels the position of the gap between two fuel bundles, between a fuel bundle and the biological protection plug or between the fuel bundle and the Ram C adaptor;
- Pushes the bundles in the storage and prevents the axial movement of the fuel column.



Fig.8 – F/M Head separators assembly

The main subassemblies of the separators (fig. 9) are:

- Sliding assembly – constituted by a palpator and a pusher (or a retractor) and two sides stoppers, each one being put in function by a piston;
- Potentiometers and magnetic microswitchers assembly that seizes the separators position.

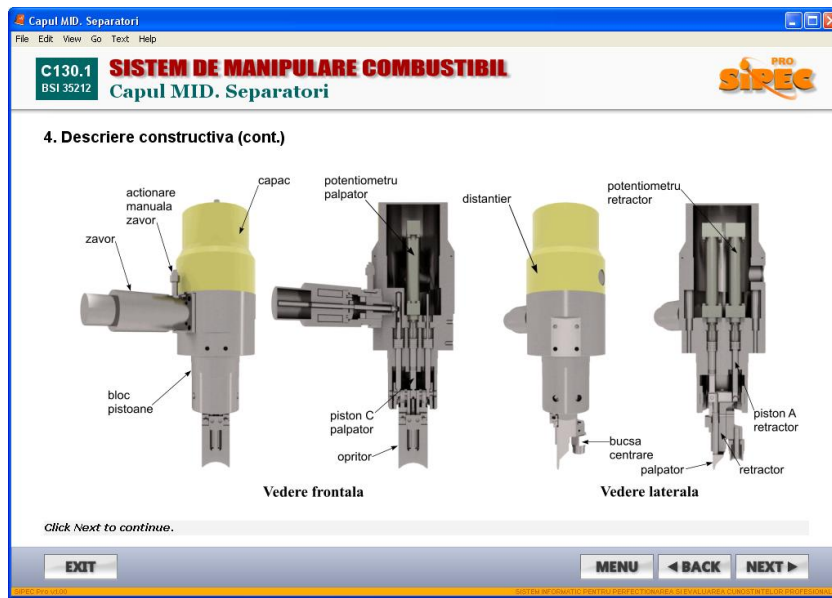


Fig.9 – F/M Head separators assembly. Constructive description

The separators are in rest in normal function position (fig. 10).

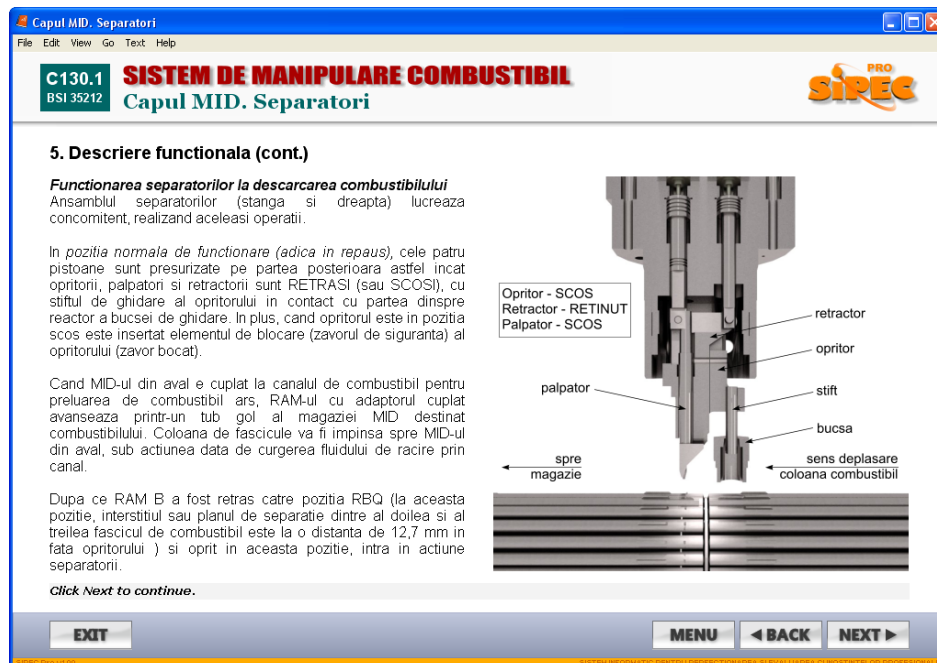


Fig.10 – The separators in rest

It is mentionable that at the end of each electronic course a questionnaire appears from the presented material, named “quiz” (fig. 11) its structure has been conceived so the complexity grade can determine different grades of difficulties.

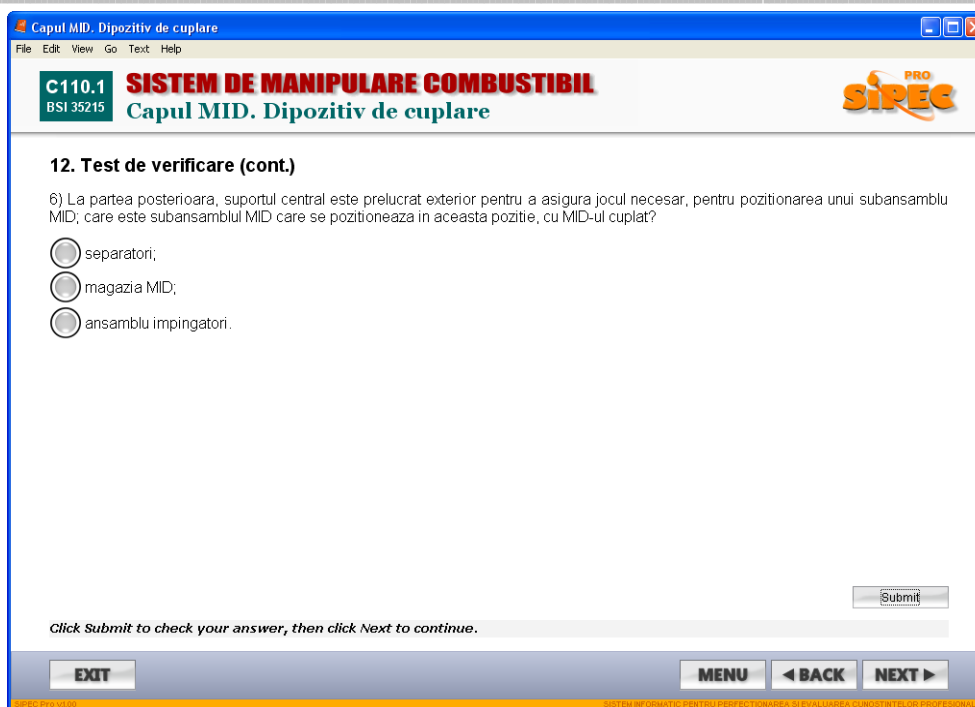


Fig. 11 – Quiz

Results

In this paper it is presented the execution mode for the courses in electronic format, parts of the Informatics System for Perfecting and Evaluating the Professional Knowledge (SIPEC Pro) of the FHS personnel, with the help of the Toolbook Instructor program, using a data base with information and knowledge about the FHS function.

Conclusion

Next to the practical activities conducted in the technological installations, this courses system contributes to the maintaing and developing of the human resources used in testing and operating of the F/M Heads at the RATEN/ICN.

References

- [1]F/M Head. Design description – code R-X81-35210-DD-001
- [2]F/M Head. Test requirements – code 2-3-35000-460A